CABLE WITH VARIABLE STIFFNESS

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 62/882,250, filed Aug. 2, 2019, the disclosure of which is incorporated herein by reference for all purposes.

BACKGROUND

[0002] This disclosure relates generally to cables such as electrical cables used to transmit power and/or data and in particular to a cable having variable stiffness along its length.

[0003] An electrical cable generally includes one or more conductive wires that can be used to transmit power and/or data between devices connected to the two ends of the cable. The cable is wrapped in an outer sleeve or sheath that provides electrical insulation and protection from the elements. Where the cable includes multiple conductive wires, the outer sleeve also holds the wires together, making the cable easier to manage.

[0004] Depending on the particular application, an end of a cable can be connected into a connector (e.g., a plug-type connector) or an active electronic device having contacts to which the wires of the cable are connected. It is well known that bending of the cable near the termination point may cause unwanted strain on the wire connections, which may lead to cable failure. Accordingly, it is common to provide a strain relief sleeve made of a stiff material around the end region of the cable. The stiff material creates a localized increase in the bending resistance of the cable, thereby relieving strain on the wire connections.

SUMMARY

[0005] Existing strain relief sleeves are generally formed as a separate structure placed around the outer cable sleeve. In addition to making the cable locally stiffer, the strain relief sleeve also makes the cable thicker at the ends. In some instances, the added thickness may not be desired.

[0006] Certain embodiments of the present invention relate to cables having strain relief regions integrated into the cable sleeve. In some embodiments, a cable can include a cable core having one or more signal conductors, such as electrically conductive wires. The cable core can be surrounded by an outer sleeve having a uniform thickness and further having a first longitudinal section having a first stiffness (e.g., corresponding to a flexible cable), a second longitudinal section having a second stiffness (e.g., corresponding to a rigid cable), and a third longitudinal section between the first and second longitudinal sections, where the second stiffness is greater than the first stiffness and where a stiffness of the third longitudinal section varies between the first stiffness and the second stiffness. In some embodiments, the second longitudinal section can be an end section of the cable.

[0007] In some embodiments, the outer sleeve can include a first layer made of a soft material and a second layer made of a stiff material. In the first longitudinal section, a thickness of the first layer can exceed a thickness of the second layer, while in the second longitudinal section, the thickness of the second layer exceeds the thickness of the first layer, so that the total thickness of the outer sleeve is constant along the length of the cable. In the third longitudinal section, the thickness of the first layer and the thickness of the second layer can vary along the length of the third longitudinal section such the total thickness of the outer sleeve is constant. The first layer can be inboard of (i.e., closer to the core than) the second layer, or the second layer can be inboard of the first layer.

[0008] In some embodiments, the outer sleeve can be formed of a mixed material comprising a stiff polymer and a soft polymer. In the first longitudinal section, the mixed material can contains a first ratio of the stiff polymer to the soft polymer, while in the second longitudinal section, the mixed material contains a second ratio of the stiff polymer to the soft polymer, where the first ratio is lower than the second ratio. In the third longitudinal section, the mixed material can contain a ratio of the stiff polymer to the soft polymer that varies along the length of the third longitudinal section.

[0009] According to some embodiments, a cable can include a cable core comprising one or more signal conductors (such as electrically conductive wire). The cable core can be surrounded by an outer sleeve having a uniform thickness and further having a central section having a first stiffness, an end section at each end having a second stiffness, and a transition section between each end section and the central section, wherein the second stiffness is greater than the first stiffness and wherein a stiffness of the transition section varies between the first stiffness and the second stiffness.

[0010] According to some embodiments, an assembly can include an electronic component having a housing and a cable disposed outside the housing. The cable can include a cable core comprising one or more signal conductors (e.g., electrically conductive wires) that extend through the housing and couple to the electronic component. The cable core can be surrounded by an outer sleeve having a uniform thickness and further having a central section having a first stiffness, an end section abutting the housing and having a second stiffness, and a transition section between the central section and the end section, wherein the second stiffness is greater than the first stiffness and wherein a stiffness of the transition section varies between the first stiffness and the second stiffness. In some embodiments, the end section and the transition section can provide strain relief where the cable connects to the housing.

[0011] The following detailed description together with the accompanying drawings will provide a better understanding of the nature and advantages of the claimed invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** shows a longitudinal cross-section view of a cable with integrated strain relief according to some embodiments.

[0013] FIG. **2** shows a longitudinal cross-section view of another cable with integrated strain relief according to some embodiments.

[0014] FIG. **3** shows a longitudinal cross-section view of another cable with integrated strain relief according to some embodiments.

[0015] FIG. **4** shows a simplified example of an assembly according to some embodiments.

[0016] FIG. **5** shows a simplified cross-section view of an assembly using a conventional strain relief technique.